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RECOMMENDED WASTEWATER TREATMENT GUIDELINES FOR THE HASHEMITE KINGDOM OF JORDAN

WASH FIELD REPORT NO. 17

6 APRIL, 1981

Prepared For:
USAID Mission to Amman
Order of Technical Direction No. 31

WATER AND SANITATION FOR HEALTH PROJECT

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July 13, 1981

Mr. Walter Bollinger
Mission Director
USAID Mission
Amman, Jordan

Attn: Mr. Thomas Pearson

Dear Mr Bollinger:

On behalf of the WASH Project, I am please to send you the final report of Mr. Harris F. Seidel, consultant, who visited Jordan in March and April, 1981, to review wastewater treatment plants and processes under consideration by the Government of Jordan.

This work was requested of the WASH Project by the Office of Health (ST/HEA) under Order of Technical Direction No. 31 dated 11 March 1981.

If you have any questions or comments on this report, we would be happy to hear from you.

Sincerely yours,

Dennis B. Warner

Dennis B. Warner, Ph.D., P.E.
Acting Director
WASH Project

DBW/RS
Enclosure

WASH FIELD REPORT NO. 17

JORDAN

RECOMMENDED WASTEWATER TREATMENT GUIDELINES FOR THE HASHEMITE KINGDOM OF JORDAN

Prepared for USAID Mission in Amman under
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Prepared by:
Harris F. Seidel

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Contract No. AID/DSP-C-0080
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Special appreciation is expressed to Monty Montanari of AID/Washington for personal and professional contributions. Finally, warmest thanks to Mr. James Cassanos, USAID sanitary engineer, for his contributions of sound technical and professional judgment, tactical support, much overtime and frequent hospitality throughout this assignment. It was a thoroughly pleasant experience for Mr. Seidel.

Chapter 1

INTRODUCTION

1.1 Background

On 11 March 1981 the WASH office received Order of Technical Direction (OTD) No. 31 from the USAID Office of Health (see Appendix A). The OTD was issued in response to requests from the USAID Mission in Jordan for assistance in developing wastewater treatement guidelines.

WASH consultant Harris F. Seidel visited Jordan from March 22 to April 6, 1981, during which time he reviewed preliminary engineering reports for three large sewerage projects, participated in a roundtable conference, visited the major population centers, and drafted guidelines for wastewater treatement practice appropriate to Jordan.

1.2 Scope of Work

The following was the Scope of Work to be undertaken under OTD 31:

"(a) The consultant will review and evaluate the feasibility studies and designs for all wastewater treatment plants and processes under consideration by the Government of Jordan (GOJ) in a general way for appropriateness to Jordan. In addition to first cost, special attention will be devoted to ease and cost of operation and maintenance in Jordan. These would include Irbid, Aqaba, Zarqa, Ruseifa and the plants being recommended in the feasibility studies for Greater Amman and nine smaller towns;

"(b) He will develop the basis for guidelines by participating in a roundtable conference with Jordanians and consultants selected and invited by the National Planning Council (NPC);

"(c) He will prepare an outline of the guidelines to be recommended for NPC review and comments. The consultant shall then prepare a final report containing recommendations. The recommendations shall be supported by observations and information pertinent to Jordan and its conditions."

Chapter 2

GENERAL RECOMMENDATIONS

2.1 General Concepts

1. These are intended to be guidelines, not standards, for all of Jordan.

2. It is not considered appropriate to try to set any fixed rule or target for wastewater treatment such as "secondary treatment in all cases" or "50:50 effluent from all plants."

3. To set any fixed standard ignores the obligation to look at each individual situation in terms of

   - objectives,
   - justification, and
   - financial capability

   and to make a judgment on the practical balance of human, natural (water), and money resources which would take full advantage of favorable local conditions.

4. Jordan has many environmental characteristics which are advantageous for wastewater treatment. The warm, sunny climate and long, dry season make oxidation ponds and sludge drying beds attractive. These are low-energy, non-mechanical treatment methods. Also, the topography, scope, and location of most cities on high ground provide the chance to use gravity flow methods and save pumping costs.

5. Simpler technology is highly recommended. Simple treatment process are usually easier to understand and control, are reliable, and have lower operating costs. Even at somewhat higher unit costs, a plant that works is worth two that do not.

2.2 Degree of Treatment

1. Primary treatment is a "given."

2. Conventional secondary treatment (approx. 85% ± removal) should be justified in each case where it is used. Why is it needed? Is secondary treatment needed at the start, or can it be added at a later stage? Is there at

least a general judgment that the benefit/cost balance is favorable?

3. Advanced secondary treatment (approx. 90-95% ± removal) should be subject to rigorous evaluation as to need and benefit. In this performance range, each additional percent of removal costs much more than the one just before!

4. Tertiary or advanced wastewater treatment are not recommended at this time. "Super-treatment," such as filtering and various sophisticated physical-chemical methods, should be left as a challenge for the next generation.

2.3 Wastewater Treatment Sequence--A Summary

1. First, look at the possibility of ponds.

2. For a small city, the historic Imhoff tank may be appropriate with trickling filter for secondary treatment. Sludge digestion is included in the tank.

3. The trickling filter now (again) has important advantages over activated sludge.

4. Very high performance is possible with the coupled process (trickling filter-activated sludge). If the initial design of a trickling filter plant leaves room for it, the later addition of activated sludge can be a beautiful example of staging.

5. Effluent aeration is fine if done by gravity cascade but not worth the expense of mechnical aeration.

6. Effluent chlorination is costly and is generally ineffective. Unless the effluent has been treated to reuse standards, chlorination can give a false sense of security.

2.4 Solids Handling Sequence--A Summary

1. Avoid producing sludge if possible. This can be translated as: Look at ponds first.

2. Avoid sludge thickening if possible; waste activated sludge usually requires thickening; trickling filter sludge usually does not.

3. Anaerobic digestion has a great advantage over aerobic digestion at current power costs.

4. Except for small plants, digesters should always be provided in two stages for flexibility and better control of digestion.

5. Provide open sludge drying beds if possible; sludge storage ponds can be used as a wet season backup.

6. Methane gas produced by the sludge digestion has value for plant heating needs.

7. The use of methane gas for on-site power generation is practical and economically attractive in larger plants.

8. Sludge is a resource which should be returned to the land. Its fertilizer value is small, but it is a valuable soil conditioner.

2.5 Appropriate Technology

In the March 1981 issue of Civil Engineering - ASCE, Francis Montanari emphasized the importance of using methods and systems that best fit local situations. Appropriate technology is cost effective; it is simple enough so that the system can be built, operated, and maintained by local people who already have the necessary skills.

This does not require inventing new technology nor does it mean returning to primitive, out-dated methods. Rather, Montanari describes it as "innovative applications of proven technology." Another way of putting it is: " Keep it simple."

2.5.1 Trickling Filters and Activated Sludge

For a student of the history of wastewater treatment the story of these two methods is a gold mine. The pendulum of development and popularity has alternated between them. The chronology goes something like this:

1900 ±	-	Invention of the trickling filter
1914	-	Invention of the activated sludge process
1936	-	Development of the high-rate trickling filter--a genuine "break-through"

1950's, 1960's - Development of many advanced methods of activated sludge, eclipsing the trickling filter

1970's - New plastic filter media and rising energy costs for aeration have turned the spotlight back to the trickling filter.

1980's - The most interesting recent development has been the trickling filter-activated sludge "coupled system" which can produce higher efficiencies than either process alone.

The modern trickling filter (or oxidation tower) now has important advantages.

- It is simple because it just keeps on working.
- Power cost are low because power is used only for pumping/recirculation.
- The sludge is much easier to deal with.
- Plant effluent usually has a good dissolved oxygen level.

Disadvantages are that the effluent quality is not as good as can be obtained from conventional activated sludge and the reduced efficiency caused by low winter temperatures (which are not that low in Jordan).

2.5.2 Project Staging

Successful management of a water pollution control program involves balancing many factors including:

- money
- population with access to water supply and load growth
- finances
- need for treatment; effect on receiving stream
- capital and operating funds
- plant operation skills levels

When it is not possible to do everything for everyone at once project staging becomes important. In some situations primary treatment is enough for an initial stage. This may not be possible throughout Jordan. However, in many cases conventional

secondary treatment should be adequate for a first-stage project.

It is interesting that the trickling filter-activated sludge process is ideally suited for this; trickling filters will provide good secondary treatment, and the activated sludge addition can come later as needed. The best way to summarize the staging approach is to use the familiar example of first we crawl, then walk, then run; eventually, we are ready for the Olympics.

2.5.3 Water Conservation via Toilet Technology

The introduction of modern sanitation systems usually brings with it the indoor flush toilet, where it does not already exist. Where it is already installed its use tends to increase. Sewers, therefore, result in higher water use if the water is available -- sometimes dramatically higher water use.

In the western world the flush toilet typically uses 20-25 liters per flushing. Studies indicate that this amounts to 40 percent or more of total domestic water use. Campaigns have begun to reduce this amount. For example, New York State has recently enacted a law requiring that all new flush toilets installed after a certain date must be designed with a limit of approximately 12 liters per flushing. Perhaps the Government of Jordan can take control and maintain control of such aspects of water use at this early stage in sewerage development.

It is worth noting that every liter not flushed to the sewer (and treated) does not have to be pumped from a water source in the first place. It also represents an electric power saving all the way through the water supply/wastewater treatment chain.

2.6 A Decision Sequence for Wastewater Treatment

"There are no simple solutions--only intelligent choices."

Choice No. 1: Are sewers necessary? Is the cesspool system functioning adequately? Is the groundwater supply being polluted? Can the existing system be improved enough to provide adequate public health protection? Building a sewer system may simply move a problem from the city to some point downstream.

Choice No. 2: Is treatment necessary? From the standpoint of decency and water resource protection, the answer in Jordan today appears to be: "Yes, at least primary treatment is necessary."

Choice No. 3: Is primary treatment adequate (35%/65%+)? What are the benefits of more than primary treatment? To whom or to what? What is the natural recovery ability of the receiving stream or wadi, and what use will be made of the water? Is primary treatment an intelligent first stage, followed by further treatment when the load increases or when justified by stream use?

Primary treatment alternatives

- Oxidation ponds (yes, this is more than primary treatment)
- Imhoff tank with sludge drying beds
- Conventional primary treatment; screen/grit/primary setting/sludge treatment

Choice No. 4: Is secondary treatment adequate (85%+)? Wastewaters in Jordan are now very strong, in the range of 800 to 1,000 mg/l BOD and suspended solids. This means that a reduction of 85 percent can still leave wastes of 120 to 150 mg/l discharging from secondary treatment facilities. Clearly, this raises questions about the need for even more treatment.

Again, what are the benefits? To whom or what? At the very least, there should be a time lag or staging period to allow observation of secondary treatment performance and downstream conditions. The financial side of staging must also be considered when venturing into higher degrees of treatment. Costs increase very rapidly for advanced treatment while benefits may not.

Secondary treatment alternatives

- Oxidation ponds, various combinations
- Imhoff tank followed by trickling filter
- Conventional secondary treatment; screen/grit/primary settling/biological process/secondary settling/sludge treatment. The biological process can be activated sludge or trickling filters; both have many variations of load, staging, recirculation, media, aeration, etc.
- Rotating bio discs

Choice No. 5: Is advanced secondary treatment necessary (90-95%+)? The same questions should be asked but with even more rigorous standards of justification. In this range, capital and operating costs rise with every additional percent of treatment efficiency. Will the benefits increase proportionately?

Advanced secondary treatment alternatives

- Oxidation ponds with long storage capacity
- Extended aeration; usually 24 hour detention time
- Oxidation ditches; the "race-track" system
- Conventional activated sludge systems with very long aeration times
- The coupled system, trickling filter-activated sludge, which is well adapted to staging and has very high performance potential

2.7 A Decision Sequence For Solids Handling

Solids handling is the most underrated part of the treatment process. The cost of dealing with sludge can be fully half of the total process cost, and the problems in solids handling can far outweigh all others combined. The main problem with sludge is that, just like statistics, once you collect it, you have to do something with it.

Choice No. 1: Can sludge production be avoided? Yes, by staying with oxidation ponds wherever and as long as possible. Even though sludge may have to be removed at long itnervals, it is well digested and stabilized.

Choice No. 2: Can digesters be avoided? Yes, but at a price. Extended aeration and the oxidation ditch produce sludge which has already received aerobic digestion. That sludge can be settled, thickened, and dewatered, if necessary, for final disposal. The historic Imhoff tank includes a digestion compartment as a lower story within the tank structure.

Choice No. 3: Should the methane gas be used for on-site power generation? Yes, no, and maybe, depending on many factors. Power generation requires 24-hour attendance at the plant and sufficient technical competence of the maintenance staff. An auxiliary fuel supply is needed as well as an outside power connection for backup.

As a very general rule of thumb, a power supply for a population of 100,000 should easily justify power generation at present energy costs. It might be more practical to defer generating equipment until sufficient gas is actually available rather than include it in the initial plant construction.

Choice No. 4: Can sludge drying beds be used? Where space is available, sludge drying beds should be a very practical and economical solution in Jordan's climate. The mechanical sludge dewatering process normally requires power and chemicals and

produces a potent filtrate liquor which must be returned to the wastewater stream at some point. Drying beds fit the framework of appropriate technology.

Choice No. 5: Can the sludge be returned to the land? Sludge has only a small fertilizer value (less, if digested) in terms of N-P-K. However, it is valuable as a soil conditioner and soil builder. It helps to open up tight clay soils and will improve the moisture retention of sandy soils. If landfilled or burned, there is no recovery of this useful resource. Composting with other solid wastes has been technically successful but too costly to be practical.

Chapter 3

GREATER AMMAN SEWAGE TREATMENT PRELIMINARY STUDY

3.1 Scope and Summary

The following comments and suggestions are made after brief review of the Daniel, Mann, Johnson and Mendenhall and James M. Montgomery (JMM/DMJM) reports available and a visit to the Ain Ghazal treatment plant. Proposed locations of the Suburban Projects were not visited in the limited time available.

For Ain Ghazal, it appears that the consulting engineer has done a competent, professional job of preparing alternatives. Expanding an existing treatment plant is always more difficult and challenging than planning a completely new facility. This is especially true when the site is as severely limited in size and shape as this one.

Of the two principal alternatives, Montgomery recommends conventional activated sludge (AS) for cost reasons. However, the report does recognize the advantages of the trickling filter-activated sludge (TF-AS) method. Among these advantages are the ability to absorb sudden changes in load and lower power cost. This reviewer suggests another look at the TF-AS process in light of new information. If the cost comparison is then reasonably close, the TF-AS alternative should have top ranking as the most appropriate.

Of the eight Suburban Projects, four are planned as total containment ponds; and four are activated sludge variations. The latter were selected in preference over the alternative of lined total containment faculative ponds -- an alternative recognized to require large land areas. Here again reconsideration of other methods is suggested, including pond alternatives which would require far less land and which would be designed for effluent discharge.

3.2 Ain Ghazal Treatment Plant Design Criteria

Montgomery cites the following requirements for a treatment process:

- provides a high quality secondary effluent
- minimizes energy consumption
  allows space at the agtp site for potential future increases in the quality of treatment
- provides a system which is relatively simple to operate and maintain

These criteria are considered to be well chosen, well stated, and appropriate for this study. The consultant has done a commendable job of applying them in developing proposals for expansion of this very limited plant site.

3.3 TA1 - Conventional Activated Sludge

This design concept is based on the "ultimate" flow projection of 96,000 m^3/day at this site in the year 2000. The design is somewhat conservative in that 10 to 15 hours aeration time is provided. Five hours final settling time is provided because of the light, fluffy solids to be removed at this site. The report also makes special note of the need to maintain a high solids content in the aeration tanks because of the unusual strength of the waste being treated.

Chapter 4

IRBID SEWAGE TREATMENT PLANT PRELIMINARY DESIGN

4.1 Scope and Summary

These comments are provided after a brief review of the Weston International reports on the Irbid project but without any discussion with Weston personnel.

In the initial project reports weston evaluated five mechanical treatment plant alternatives and four pond treatment alternatives at four possible sites. Project staff came away convinced that extended aeration was the answer and held to this decision even after restudy with adjusted power rates. one of the key factors in this choice was the initial decision to design a final effluent standard of 30 mg/1 BOD and 30 mg/1 suspended solids, a plant efficiency of 96+%

The choice of extended aeration is not appropriate in this instance. It is not a particularly complex process, but neither is it simple. Power use is very high. It would be very difficult to justify the use of this process for this large a plant. In current vernacular it is simply not "appropriate technology."

The pre-set goal of 30:30 effluent is also inappropriate. Although it is a very desirable long-term objective under present conditions the principal beneficiary would be the Wadi Arab, at high cost.

Specific recommendations are as follows:

- Take a second serious look at ponds. This should preferably be by someone who thoroughly understands ponds.

- If ponds are finally judged to be impractical for irbid, turn to conventional mechanical treatment. The trickling filter type of plant would appear to be most practical. It should be designed for addition of activated sludge later to achieve higher performance.

4.2 Weston Preliminary Reports

4.2.1 Initial Alternatives

In Weston's preliminary reports (March, August, and November 1980 and January 1981), five types of essentially mechanical

treatment plants were evaluated. For these, primary consideration was given to site one, adjacent to the municipal slaughter house on the northwest side of Irbid. Those alternatives were identified as mediuam technology (MT).

Consideration was also given to four types of oxidation pond treatment. For these types primary consideration was given to site three, a sloping area of open fields approximately one kilometer north of site one. these alternatives were identified as low technology (LT). In either case, discharge of treated effluent would be to Wadi Hamam, which in turn enters wadi el arab several kilometers downstream.

4.2.2 Mechanical Plants

Extended aeration was initially recommended as the least cost alternative able to meet the high quality of effluent standard (30:30). Simplicity of the process was also given as a justification for this choice.

Extended aeration is only partly "simple." It can be considered a "no-decision" process since the waste is simply held, mixed and aerated for 24 hours in an apparent effort to wear it out. Organic matter is stabilized and solids receive aerobic digestion in the aeration tanks. However, power use is very high and usually the operator has no choice but to run the equipment continuously. Equipment maintenance and sludge handling from the process are not simple.

The January 1981 restudy of the initial and several new mechanical treatment alternatives took into account the new power costs. This restudy showed that extended aeration is no longer the least cost alternative on a total annual cost basis. On a cumulative present worth basis, it is in fact now the highest cost alternative, still based on the 30:30 effluent standard. However, Weston holds to the recommendation of extended aeration, based on effluent quality and suggests a power subsidy to offset its high cost.

Ponds

The reports available provided very little information on the pond proposals. No design criteria were given, except for the facultative ponds, LT-1. Therefore no judgment can be made on land areas specified for the other pond alternatives.

In some respects the pond alternatives appear to be overdesigned and over-costed. Capital and power costs for aeration

appear unreasonably high. LT-3 is followed by slow sand filters. LT-5 and -7 are provided with final clarification and sludge drying beds. In fact, the estimated drying bed costs are 75 percent of those for the mechanical plants. Labor costs for the ponds are also generally about 75 percent of those for the mechanical plants which is incredible.

The January 1981 restudy with new power rates indicates that LT-3 (anaerobic/aerobic ponds) is approximately equal in cost to extended aeration. However, when population figures for Irbid were revised downward to 74 percent of earlier estimates, pond land areas and costs were never adjusted accordingly. Such an adjustment for LT-3, for example, would mean 0.5 million Jordanian Dinars less for land purchase and lower total annual costs.

Even in the weston approach a pond method now becomes the least cost alternative after all these adjustments are made. This conclusion does not dictate that a pond shall be built for Irbid. However, it finally does confirm the conventional wisdom that a pond will always cost less than a mechanical plant. To disprove this contention would require some strange circumstances.

4.3 Current Status

4.3.1 Choices Now

Where to go from here? That is the question. The following two alternatives are suggested in order of choice.

1. Turn back and take a serious careful second look at ponds.

2. If ponds are then finally judged to be impractical, proceed with a mechnical treatment plant other than extended aeration.

4.3.2 The Pond Approach

One approach could be to purchase the proposed site one, construct a pumping station there, then also purchase 20 to 30 hectares at site three and begin construction of a pond system there. Here is where imagination and ingenuity could enter in.

Construction could begin with anaerobic cells, followed by facultative ponds, in series for best results. As the population

load increased additional ponds and aerators could be added, drawing on experience gained in actual operation. The slope of the site would lend itself to construction of a series of ponds at decreasing elevations.

How large a poplation might such a system serve? By the Weston analysis a population of 265,000 could be served by an anaerobic/aerated pond system requiring 20 hectares in total area. This may be beyond the practical limits of ponds for irbid, but it does provide some perspective on capacity of this method.

Later, when ponds are no longer the answer, a mechanical treatment plant can be built on site one (already owned) and the pond area can be converted at moderate cost for sludge drying beds just as proposed in the weston plans for development of site one. If sludge drying beds are out of style when that happens, site three can be sold for other development -- probably at a handsome profit!

4.3.3 The Mechanical Approach

This approach would involve purchasing site one for a conventional mechanical plant and purchasing needed land north of Wadi Hamam for sludge drying beds as proposed by Weston.

The plant design should be as simple and reliable as possible. Emphasis should also be placed on low energy requirements and low overall operating costs. These criteria are best satisfied by new alternative six in the Weston restudy dated January 1981. It is suggested that the activated sludge step shown be deferred until clearly justified. Obviously the initial plant design should provide space and hydraulic room for including activated sludge process later.

The plant design concept would then consist of preliminary treatment, primary clarifiers, trickling filters, final clarifiers and discharge. Sludge would be pumped to two-stage anerobic digesters, followed by open drying beds. Sludge thickening should not be necessary. Cascade re-aeration could be provided if hydraulics permit; mechnical re-aeration could not be justified. Note that the gas engine-generator installation is also deferred until the load builds up enough to justify on-site power generation.

Chapter 5

ZARQA SEWAGE TREATMENT PLANT PRELIMINARY DESIGN

5.1 Scope and Summary

The following comments are the result of a rather brief study of the preliminary reports and design calculations for the Zarqa plant followed by the meeting with MPI representatives and NPC staff on March 31 for more detailed discussion of the design concept.

As an overall judgment the design concept is considered to be good. The unit treatment process methods used are well-proven and established. None would be considered very complex or sensitive. Operating control should be relatively simple. Staffing requirement will be reasonable and power costs relatively low. Good use is made of the advantages of climate and slope of the site. The use of methane gas for power generation is strongly encouraged and should provide a good financial return. The mechanical and electrical equipment for this energy recovery, and in the rest of the plant should be well within the capability of local technical talent to operate and maintain properly.

It is specifically recommended that:

- chlorination be entirely eliminated
- the size of sludge drying beds (individual beds, not total area) be reduced
- there be an outside power connection for standby power
- MPI be requested to take another look at depth of the trickling filter towers
- GOJ insist on adequate piping to provide operating flexibility rather than the rigid isolated "train" system first proposed by MPI.

5.2 General Aspects

5.2.1 Site Space

This site had good location and topography. If the 28 hectares are purchased as proposed, there will be plenty of space for sludge drying beds up to the year 2000. After that, additional treatment structures can be placed in the sludge drying area which would be sufficient to meet projected population and industrial growth up to the year 2020.

5.2.2 Staging or Phasing

The initial construction will consist of two each of the principal treatment elements. A third unit of each can be added as needed then a fourth, fifth, etc. this approach makes good sense from the financial as well as operating standpoint.

5.2.3 Flexibility

The design concept is based on separation of the plant units into individual "trains" (primary clarifier, trickling filter, secondary clarifier) in such a way that if one of the units in a train is out service, the entire train is out of service. Moreover, there is no provision for "cross-over" between trains. This lack of any flexibility will create an operating problem and will result in serious shock loads on the Zarqa River every time any unit has to be taken out of service. The consulting engineer MPI has agreed to revise the design to provide some additional piping and flexibility.

5.2.4 Hydraulics

Complete gravity flow-through is not possible at this site, and pumping to the trickling filters is a necessity. One point which was overlooked during the discussion on March 31 is the relative setting of the filters. It appears that they could be placed several meters higher in elevation. This modification would in turn provide several meters additional fall at the effluent end of the plant for cascade aeration if desired.

5.3 Liquid Flow Sequence

Screens

The design is considered appropriate and no comment is offered.

Grit Removal

The design is considered appropriate and no comment is offered.

Flow Metering

A single master flow metering channel such as a Parshall Flume could be provided somewhere ahead of the primary clarifiers. Such a channel is proposed for measuring plant effluent discharging to the stream. Either one is acceptable.

Pre-chlorination

Very little, if anything, will be accomplished by this technique and it should be eliminated.

Oil and Grease Removal

This step was not included in the original design concept. however, based on experience and observation at Ain Ghazal, MPI has decided to provide an oil skimming and removal arrangement ahead of the primary clarifiers.

Primary Clarifiers

The primary clarifiers are designed rather conservatively. That is, they are somewhat larger than might be necessary. This is not a crime. One reason was so that the primary and secondary clarifiers could be essentially alike for economy of construction and conformity of equipment. One way to take advantage of this would be to omit the primary clarifier when the third treatment train is added. The resulting settling time of approximately 1-1/2 hours should provide enough primary removal ahead of the more efficient biological treatment step.

Trickling Filters

A long discussion on this subject yielded no result. MPI remains adamant that the proposed design depth of 36 feet for the plastic media tower is the least cost design. However, MPI recognized that the justification is highly theoretical and only actual operating experience will yield the answer. The 36 feet depth is pushing formula too far, and a safer depth would be perhaps 30 feet. This depth would require more media volume and more recirculation (by the formula) but six feet less pumping head forever after. However, it is also recognized that only operating experience will yield the answer.

Second Clarifier

The design is considered appropriate and no comment is offered.

Post-chlorination

Chlorination of sewage effluent of this strength is very costly and cannot be really effective because of the ammonia and solids contents of the effluent. Another aspect is the delusion that something is being done to guarantee the health of all downstream water users and lettuce lovers. Actually this objective will not be achieved. For all these reasons, chlorination should be eliminated from the design.

Aeration

Design proposals have included either cascade or mechanical aeration, depending on how much elevation remained available at the effluent end of the plant. Cascade aeration is encouraged if possible (see comment on Hydraulics). However, the cost of mechanical aeration is definitely not justified by the small temporary gain in dissolved oxygen and this should be eliminated from consideration.

5.4 Solids handling Sequence

Primary Digesters

The design is considered appropriate. This reviewer commends MPI for providing a ground-level side access manhole for easier entry and cleaning the digesters, both primary and secondary. One important addition to the mixing system proposed would be a time clock control of the external mixing so that pumping could be intermittent, with a saving in power.

Secondary Digesters

The design is considered appropriate and no comment is offered.

Supernatant

Digester supernatant is a very strong waste in itself. The design proposes returning it to the pumping wells for direct

application to the trickling filters. It would be preferable to have a side treatment system for the supernatant before it is returned to the main flow sequence. However, this can be added later depending on actual operating experience.

Sludge Drying Beds

The drying beds proposed are far too large, not in total area but individually. The sludge draw-off to fill one bed of 122 m x 15 m area would be approximately 570 m^3, which is too much to draw from a digester at one time. Also the entire sludge drying and disposal operation will be much more flexible and convenient with perhaps four to five times as many smaller beds.

Electric Power

The design concept calls for complete power self-sufficiency, isolated from the electric power authority. Power was to be provided solely by one of two dual-fuel diesel engine-generator sets. After discussion MPI agreed to review the physical and economic aspects of an outside power connection as the standby, rather than additional engine-generator capacity. The outside power connection is strongly recommended as well as negotiations toward eventual synchronized on-line service through which the treatment plant could deliver excess energy to the power authority. There is no question that power generation from methane gas will be financially attractive. The most efficient operation could probably be achieved by installing two smaller units (such as one 150 kilowatt and one 299 kilowatt) rather than one 350 kilowatt engine-generation set initially.

APPENDIX A
Camp, Dresser & McKee, Inc.
WASH PROJECT

MAR 11 1981

MEMORANDUM March 11, 1981

Water and Sanitation for Health (WASH) Project
Order of Technical Direction (OTD) Number 31

TO: Mr. James Arbuthnot, P.E.
WASH Contract Project Director

FROM: Mr. Victor W.R. Wehman, Jr., P.E., R.S. VWW
AID WASH Project Manager

SUBJECT: Provision of Technical Assistance Under WASH Project Scope of Work for USAID/Jordan

REFS:
A) Memo Mohn/Arbuthnot, 23 Feb 81
B) Amman 1269, 19 Feb 81
C) State 40927, 18 Feb 81
D) Memo Arbuthnot/Mohn, 3 Feb 81
E) State 24987, 31 Jan 81
F) Amman 00594, 26 Jan 81
G) Amman 08393, 18 Dec 81
H) Amman 08230, 11 Dec 81

1. WASH Contractor requested to provide technical assistance to USAID/Jordan as per Ref. C and Ref. B.

2. WASH Contractor/sub-contractor/consultants authorized to expend up to 33 person days efforts over a three-month period to accomplish this technical assistance.

3. Contractor to provide draft final (typed) report to mission before leaving mission. Final report due DS/HEA and mission with 30 days of consultant leaving Jordan.

4. Contractor to coordinate directly with USAID/Jordan, with Mr. Tom Pearson (See Ref. B); with Jordan AID desk officer (as appropriate); with NE/PD/ENGR, Mr. Montanari; and with NE/PD Project Officer, Ms. Morn (as appropriate).

5. WASH AID Project Manager recommends that WASH Contractor use technical assistance personnel recommended by mission and NE/PD/ENGR for this effort.

6. WASH Contractor authorized to allow consultant to make one (1) international round trip into and out of Amman, Jordan to his/her home base through Washington, D.C., as appropriate, during the technical assistance effort. Consultant should definitely come to Washington for briefing before consultation and debriefing after consultation.

7. WASH Contractor authorized up to 29 days international and domestic per diem to accomplish effort.

8. WASH Contractor authorized local Jordan travel as necessary to ensure consultant accomplishes mission.

9. WASH Contractor authorized secretarial services, xerox services, graphic services, and miscellaneous expenses as necessary to accomplish mission.

10. Suggest consultant periodically phone contractor to report progress at suitable intervals to ensure consultant adequately backstopped in the field.

11. Mission and coordination points in Washington should be contacted immediately and technical assistance initiated as soon as possible and convenient to USAID/Jordan.

12. As this is a team effort involving AID direct-hire staff, mission PSC staff and WASH consultants, WASH consultant will report to Mr. Tom Pearson (representing client) while in-country or his representative and to WASH Project Director while in U.S.

13. Appreciate your prompt attention to this matter. Good luck.

VWW:ja:3/11/31

UNITED STATES GOVERNMENT

memorandum

DATE: February 23, 1980

REPLY TO ATTN OF: NE/PD/SJILO, Andrea Mohr

SUBJECT: Consultant for Wastewater Treatment Design Review, Jordan - Harris Seidel

TO: Mr. James Arbuthnot, WASH Project c/o DS/HEA

Attached:

(A) State Cable 040927 of Feb. 18, 1981
(B) Amman Cable 01269 of Feb. 19, 1981
(C) Amman Cable 00594 of Jan. 26, 1981
(E) Amman Cable 08393 of Dec. 18, 1980
(D) Amman Cable 08230 of Dec. 11, 1980

The scope of work and schedule for Harris Seidel detailed in reference A were approved by USAID/Amman in reference B. WASH should take the action from this point. As Mr. Coulter is not available soon enough for a Jordan assignment, Mr. Seidel will be the only outside consultant contemplated to be provided by WASH for this scope of work. Engineer Jim Cassanos, USAID and Mr. Montanari AID/W/ENGR will complete the design review team. (Reference C)

Note that proposed ETA Jordan for Seidel is March 20. He presently plans to arrive in Washington, D.C. on March 18th and leave for Jordan via London with Mr. Montanari on the evening of March 19th. In the interest of efficient processing and coordination between the many parties involved, you and I will need to keep in close contact so that we both are aware of the latest developments. Should you need any further documents to enable you to contract Mr. Seidel, please let me know.

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Department of State

INCOMING TELEGRAM

Ref 2

PAGE 01 AMMAN 01269 191325Z 005010 AID9008
ACTION AID-35

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UNCLAS AMMAN 01269

AIDAC

E.O. 12065: N/A
SUBJECT: WASTEWATER TREATMENT GUIDLINES - SCOPE OF WORK FOR HARRIS SEIDEL

REF: STATE 040927

1. SCHEDULE AND SCOPE OF WORK ACCEPTABLE. IN ADDITION SEIDEL SHOULD BE PREPARED DISCUSS EFFLUENT QUALITY AND STANDARDS AND SELF-PURIFICATION OF RECEIVING WATERS AS THEY RELATE TO DEGREE OF TREATMENT.

2. FOR PIO/T, IN CLAUSE 22B ENTER "NATIONAL PLANNING COUNCIL OFFICIALS AS APPROPRIATE" AND IN CLAUSE 22C ENTER NAME OF TOM PEARSON. REGARDING SUPPORT SERVICES (CLAUSE 23A), COOPERATING COUNTRY WILL SUPPLY ITEMS (1), (2) AND (6) AND AID WILL SUPPLY ITEMS (6) AND (8). ITEMS (3), (4), (5) AND (10) ARE NOT APPLICABLE. ASSUME WASH PROJECT WILL SUPPLY REST OF ITEMS, INCLUDING PER DIEM.

3. PLEASE ADVISE SEIDEL ETA WHEN KNOWN AND MONTANARIS SCHEDULE.
ZWEIFEL

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2/20/81

ACTION TAKEN
N.A.N. ☐
REPLIED ☐
TYPE INITIALS DATE
REMARKS:
Griffin 2-26-81

Department of State

OUTGOING TELEGRAM

Ref A

PAGE 01 STATE 040927 003647 AID7655
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AID/NE/PD/SJILO:D MCCALL
AID/NE/PD/ENGR:F MONTANARI
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AIDAC

E.O. 12065: N/A

TAGS:

SUBJECT: WASTE WATER TREATMENT GUIDELINES - SCOPE OF WORK FOR HARRIS SEIDEL

REF: (A) AMMAN 05230 (B) AMMAN 02333 (C) AMMAN 02595 (D) STATE-PRIORITY 2/11/81 (E) AMMAN 01105

1. FOLLOWING IS SUGGESTED PROGRAM FOR SEIDEL: TOTAL 25 CALENDAR DAYS: TRAVEL 4 DAYS - ETA JORDAN MARCH 20; WORK-DAYS - 18 (2 IN AID/W, 15 IN JORDAN); REST DAYS - 3 (MAR. 21, 27, APRIL 3). FINANCING AND TRAVEL ARRANGEMENTS - TO BE PROVIDED BY AID THROUGH WASH PROJECT.

2. PROPOSED PROGRAM FOR 16 WORK DAYS: 2 DAYS PRIOR REVIEW; 1 DAY - CONSULTATION IN AID/W; FIRST 5 DAYS - CONSULTATION NPC AND USAID, TREATMENT PLANT SITE VISITS; THEN 3 DAYS - ROUNDTABLE DISCUSSIONS WITH USAID, NPC AND OTHER GOJ AGENCIES, AND PERTINENT CONSULTANTS; THEN 2 DAYS - PREPARATION OF OUTLINE OF RECOMMENDED GUIDELINES; 1 DAY - DISCUSSION OF OUTLINE; 3 DAYS - PREPARATION OF FINAL REPORT; 1 DAY - FINAL PRESENTATION TO NPC.

3. PROPOSED TERMS OF REFERENCE: (A) PURPOSE AND (B) BACK-GROUND: AS OUTLINED IN REFTELS, A AND B AND C; (C) SPE-CIFIC SCOPE OF WORK AS FOLLOWS:
(A) THE CONSULTANT WILL REVIEW AND EVALUATE THE FEASIBILITY STUDIES AND DESIGNS FOR ALL WASTEWATER TREATMENT PLANTS AND PROCESSES UNDER CONSIDERATION BY THE GOJ IN A GENERAL WAY FOR APPROPRIATENESS TO JORDAN. IN ADDITION TO FIRST COST, SPECIAL ATTENTION WILL BE DEVOTED TO EASE AND COST OF OPER-ATION AND MAINTENANCE IN JORDAN. THESE WOULD INCLUDE IRBID, AQABA, ZARQA-RUSEIFA AND THE PLANTS BEING RECOMMEND-ED IN THE FEASIBILITY STUDIES FOR GREATER AMMAN AND NINE SMALLER TOWNS;

(B) HE WILL DEVELOP THE BASIS FOR GUIDELINES BY PARTICI-PATING IN A ROUND-TABLE CONFERENCE WITH JORDANIANS AND CON-SULTANTS SELECTED AND INVITED BY THE NPC, AND USAID PERSON-NEL.

(C) HE WILL PREPARE AN OUTLINE OF THE GUIDELINES TO BE RE-COMMENDED FOR NPC REVIEW AND COMMENTS. THE CONSULTANT SHALL THEN PREPARE A FINAL REPORT CONTAINING RECOMMENDA-TIONS. THE RECOMMENDATIONS SHALL BE SUPPORTED BY OBSERVA-

STATE 040927 003647 AID7655

TIONS AND INFORMATION PERTINENT TO JORDAN AND ITS CONDI-TIONS.

4. SUPPORT SERVICES: THE NATIONAL PLANNING COMMISSION AND THE USAID MISSION TO JORDAN WILL PROVIDE NECESSARY OFFICE SPACE AND SUPPORT SERVICES SUCH AS SECRETARIAL, REPRODUC-TION AND LOCAL AND IN-COUNTRY TRANSPORTATION.

5. PLEASE ADVISE ANY DESIRED CHANGES IN ABOVE. FOR PIO/T NEED TO KNOW WHO SEIDEL WILL BE OFFICIALLY WORKING FOR AND WITH, AND WHO WILL SUPPLY WHAT SUPPORT SERVICES.

6. SEIDEL COMMITMENTS PRECLUDE ARRIVAL PRIOR TO MARCH 21. REQUEST MISSION DISCUSS ROUNDTABLE SCHEDULE (MARCH 28-30) ASAP WITH NPC AND CONSULTANT REPRESENTATIVES TO ALLOW SUF-FICIENT TIME FOR SETTING-UP PROPER FIRM REPRESENTATION. HAIG

MEMORANDUM

February 3, 1981

TO: Andrea Mohn, NE/PD

FROM: James Arbuthnot, WASH Project c/o DS/HEA

SUBJECT: Harris Seidel, Proposed Consultant on Waste Water Treatment Guidelines, Jordan

I asked Mr. Harris Seidel of Ames, Iowa, on 3 Feb. 1981, by telephone, just what parts of a possible assignment to develop waste water treatment guidelines in Jordan he would feel comfortable with.

The answer was that he would not want to review in detail plans for sewage treatment works. He would prefer not to attempt to answer questions as to whether settling tanks were sized properly, or whether filters had the proper media, for instance.

On the other hand, Mr. Seidel said he would feel quite comfortable providing an overview of plans for sewage treatment works with the intent to recommend which types of treatment processes were suitable for Jordanian conditions. Mr. Seidel is also accustomed to make studies of financial feasibility for sewerage and sewage treatment works, economic studies, and studies to develope affordable rate structures for sewerage.

Mr. Seidel is available "late in March and in April". He would not want to spend as much time as four weeks in Jordan. Mr. Seidel was agreeable to working for Camp Dresser and McKee and the WASH Project for $192.70 which is the maximum we can pay.

On its part Camp Dresser and McKee, and the WASH Project would be willing to provide the services of Mr. Seidel to the Jordan Mission, upon request, and with the approval of DS/HEA, for work similiar to that described in the third paragraph of this memo if this is desired by the parties.

We would not want to provide the services of Mr. Seidel in Jordan for review of details of designs of sewage treatment works.

JA:jml

cc: CIC Task #67
Victor Wehman, Project Manager
Harris Seidel

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Department of State

OUTGOING TELEGRAM

PAGE 01 STATE 024987 066567 AID1826
ORIGIN AID-35

ORIGIN OFFICE NEPD-04
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AIDAC

E.O. 12065: N/A

TAGS:

SUBJECT: WASTEWATER TREATMENT GUIDELINES - COULTER, SEIDEL

REF: (A) AMMAN 0594, (B) AMMAN 506

1. CANDIDATES AVAILABILITY: SEIDEL AVAILABLE BACK TO BACK WITH LEBANON TRIP, I.E., MARCH 7. COULTER CHECKING WITH GOVERNOR OF MD. FOR PERMISSION TO TAKE ASSIGNMENT WILL ADVISE.

2. COST - BOTH CANDIDATES AGREE TO STAY AT MAXIMUM FSR-1 RATE OF COMPENSATION.

3. WASH CONTACTED A.D ARE REVIEWING COULTER AND SEIDEL BIODATA. WILL ADVISE SOONEST IF WASH WILL FUND AND IF CANDIDATES AGREEABLE WITH WASH ARRANGEMENTS. HAIG

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Department of State

INCOMING TELEGRAM

R4 C.

PAGE 01 AMMAN 00834 231540Z 052755 AID7913
ACTION AID-35

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TO SECSTATE WASHDC PRIORITY 9731

UNCLAS AMMAN 00834

AIDAC

E.O. 12065: N/A
SUBJECT: WASTEWATER TREATMENT GUIDELINES

REF: (A) AMMAN 00505, (B) 80 AMMAN 9209
(C) 2-WAY MEMO FEDEL TO HARRELL - 12/24/80

1. IN PARA 2, REFTEL A, WE REQUESTED ESTIMATE OF COST OF PROVIDING SERVICES OF SEIDEL AND COULTER. IN REFTEL B, WE HAD SUGGESTED THAT THESE SERVICES BE OBTAINED AND FINANCED THROUGH THE WASH PROJECT. IN MEMO ATTACHED TO REF C, MONTANARI DISCOURAGED EXPLORING WASH AS SOURCE OF EXPERTISE AND STATED THAT WASH PROJECT WAS NOT INTENDED TO DEAL WITH HIGH-TECHNOLOGY LARGE PROJECT PROBLEMS. IN THIS CASE, HOWEVER, EXPERTS WILL BE CONCERNED WITH FULL SPECTRUM OF WASTEWATER TREATMENT RATHER THAN JUST THE HIGH TECHNOLOGY OF LARGE PROJECTS.

2. IN ADDITION TO LARGE PROJECTS NOW BEING STUDIED OR DESIGNED, GOJ HAS REQUESTED OR PLANS TO REQUEST AID ASSISTANCE FOR FEASIBILITY STUDIES FOR NINE SMALL TOWNS. FOR THESE SMALL TOWNS, AND FOR SMALLER TOWNS AND VILLAGES THAT WILL BE STUDIED BY JORDANIAN CONSULTANTS, GOJ ENVISAGES ENERGY-FREE OR LOW-ENERGY TREATMENT PLANTS THAT ARE EASY TO BUILD AND OPERATE. THUS DISCUSSIONS BY EXPERTS WILL COVER SIMPLE AS WELL AS COMPLICATED TECHNOLOGIES, AS APPROPRIATE.

3. WE BELIEVE THIS ACTIVITY WITHIN SCOPE OF WASH PROJECT AND WOULD BE EXCELLENT USE OF THAT RESOURCE. ASSUME WASH CONTRACTOR WOULD BE WILLING FINANCE SERVICES OF SEIDEL AND COULTER.

4. PLEASE ADVISE PRIORITY SO THAT WE CAN DISCUSS ARRANGEMENTS WITH GOJ.
ZWEIFEL

FILE

NE/PD-1[illegible]

ACTION TAKEN

PAGE 01 AMMAN 08393 181431Z 0415:9 AID6398
ACTION AID-35

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TO SECSTATE WASHDC PRIORITY 9254

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AIDAC

E.O. 12065: N/A
SUBJECT: WASTEWATER TREATMENT SYSTEM

REF: (A) AMMAN 8337, (B) AMMAN 8233

1. FURTHER TO REFTELS, WE NOTED THAT WE MAY NOT HAVE EMPHASIZED SUFFICIENTLY THE REQUIREMENT FOR ASSISTANCE TO INCLUDE SOMECNE THOROUGHLY EXPERIENCED IN OPERATING VARIOUS TYPES OF TREATMENT PLANTS FOR CONSIDERING OPERATION AND ENVIRONMENTAL PROBLEMS IN JORDAN. ADDITIONALLY AFTER BRIEF DISCUSSION WITH NPC ON THIS SUBJECT WE ARE INCLINED TO BELIEVE THE BEST PROCEDURE TO FOLLOW IS FOR THE EXPERTS, POSSIBLY AFTER REVIEW OF THE EXISTING FEASIBILITY STUDIES, TO COME TO JORDAN AND CONDUCT A ROUND TABLE DISCUSSION ON THIS MATTER WITH GOJ CONSULTANTS, OTHER GOJ ADVISORS PRESENTLY IN JORDAN AND ALL CONCERNED JORDANIAN OFFICIALS.
2. WE APOLOGIZE FOR SENDING OUR REQUEST TO YOU IN WHAT MAY APPEAR TO BE A PIECEMEAL FASHION BUT AS IDEAS OCCUR WE BELIEVE IT WILL BE HELPFUL TO BOTH OF US TO CONVEY THEM TO YOU. VELIOTES

Ref D

PAGE 01 AMMAN 08230 111142Z 036557 AID1216
ACTION AID-35

ACTION OFFICE NEAL-01
INFO NEPD-03 NECP-02 NETC-04 STA-10 ENGR-02 CHB-01 RELO-01
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AIDAC

E.O. 12065:N/A
SUBJECT: WASTEWATER TREATMENT SYSTEM

1. USAID AND MPC HAVE BEEN DISCUSSING ON A VERY INFORMAL BASIS THE NEED AND VALUE TO CONSIDER "STANDARDIZATION" OF PLANTS AND PROCESSES FOR THE TREATMENT OF WASTEWATER. AS AID/W AWARE THERE ARE ONLY TWO WASTEWATER TREATMENT PLANTS IN JORDAN - AMMAN AND SALT -.

THERE ARE A NUMBER OF PROJECTS UNDER CONSIDERATION, INCLUDING FEASIBILITY STUDIES FOR MAJOR CITIES AND SMALLER RURAL CITIES. MPC, MMREA, WSC AND OTHERS ARE NOW IN THE PROCESS OF REVIEWING THE DESIGNS FOR TWO PLANTS AND CONSIDERING ALTERNATIVES PRESENTED IN VARIOUS FEASIBILITY STUDIES. EACH CONSULTANT RECOMMENDS A DIFFERENT TYPE OF TREATMENT. SOME ARE CAPITAL INTENSIVE, HIGH TECHNOLOGY, RELATIVELY HIGH OPERATION COST (INCLUDING POWER COST), OTHERS MORE SIMPLIFIED EASY TO OPERATE. ALL REGORTEDLY PROVIDE THE SAME QUALITY OF EFFLUENT. KNOWLEDGEABLE PEOPLE TO EVALUATE AND PROVIDE EXPERT GUIDANCE AND OPINION ON ALL OF THE ALTERNATIVES BEING PRESENTED TO THE GOJ ARE LIMITED. THEREFORE, IT MIGHT BE DESIRABLE TO PROVIDE ASSISTANCE TO THE GOJ IN THE FORM OF A STUDY OF THE VARIOUS TYPES OF TREATMENT PLANTS TO ESTABLISH SOME SORT OF CRITERIA FOR BEST MEETING THE REQUIREMENT. SHOULD THIS NOT BE PRACTICAL,OR EVEN IF IT IS, IT MIGHT BE DESIRABLE TO PROVIDE IMMEDIATE ASSISTANCE TO GOJ IN CONSIDERING THE DESIGN AND SELECTION OF VARICUS PLANTS NOW BEING EVALUATED BY THE GOJ. THESE WOULD INCLUDE IRBID, AQABA, ZARQA-RUSEIFA AND THE PLANTS BEING RECOMMENDED IN THE FEASIBILITY STUDIES FOR GREATER AMMAN.

2. IN ADDITION TO THE ABOVE PLANTS, THE GOJ IS IN THE PROCESS OF CONDUCTING FEASIBILITY STUDIES FOR FOUR CITIES IN THE SOUTHERN REGION OF JORDAN AND WILL BE VERY SOON REQUESTING PROPOSALS FOR A STUDY COVERING FIVE CITIES IN THE NORTH.

3. USAID WOULD LIKE TO INVESTIGATE WAYS AND MEANS OF PROVIDING SUCH SERVICES SO THAT THIS SUBJECT CAN BE DISCUSSED FURTHER WITH THE GOJ. WE BELIEVE THAT THE CONTRACTOR FOR THE "WASH PROJECT" WOULD BE MORE APPROPRIATE IN THIS CASE THAN SEEKING ASSISTANCE THROUGH THE IGC ROUTE. WE BELIEVE IT IS NECESSARY TO ASSIST GOJ TO ACQUIRE SERVICES OF A VERY HIGHLY QUALIFIED ENGINEER AND POSSIBLY FINANCIAL EXPERT PARTICULARLY SINCE GOJ IS INTERESTED IN EVALUATING THE COST OF POWER AND OTHER OPERATING COSTS VERSUS CAPITAL COST.

4. SINCE PROJECTS MAY BE DELAYED WHILE ALTERNATIVES

AMMAN 08230 111142Z 036557 AID1216
ARE BEING CONSIDERED, USAID BELIEVES THAT, IF THE ASSISTANCE IS TO BE PROVIDED, IT NEEDS TO BE PROVIDED IN THE VERY IMMEDIATE FUTURE. WE WOULD APPRECIATE AID/W COMMENTS AND SUGGESTIONS. USAID ASSUMES YOU CAN REACH CASSANOS IF YOU WISH DISCUSS ABOVE WITH HIM. VELIOTES

APPENDIX B

Itinerary

Locations Visited in Jordan

20 March	-	Arrived in Amman, Jordan
22 March	-	Amman, Ain Ghazal treatment plant
23 March	-	Suhweileh, Salt, including treatment plant; Shu'eib reservoir; Dead Sea (a tourist stop); Karama; Swaileh; Deir Abu Sa'id; Ajloun; Ein Janneh; Anajara; Jerash
24 March	-	Irbid: Ramtha; Mafraq; Zarqa; Ruseifa
25 March	-	Madaba: Karak; Tafileh; Ma'an; Aqaba
26 March	-	Wadi Musa; Petra (a tourist stop); Shaubak
28-29 March	-	Roundtable conference with NPC
29 March	-	King Talal Reservoir and Dam
31 March	-	Review of Zarqua treatment plant design
6 April	-	Departed Jordan

APPENDIX C

List of Conference Participants (March 28, 1981)

Water Supply Corporation (W.S.C.)

Said Beno
Aref Baha - Eddin
Human Ghuneim
Erik Berg

Amman Water Sewerage Authority (AWSA)

Ahmed Hadidi

Jordan Valley Authority (JVA)

Basim Mar'i

Natural Resources Authority (NRA)

--

Royal Scientific society (RSS)

Hani Shaka'a
Arafat Tamini

University of Jordan (UOJ)

Fuad Hashwa
Elias Salameh
Gerd Foerch

Ministry of Agriculture (MOA)

Naji Haddadin
Salem Okour

Ministry of Health (MOH) Environmental Health

Mohamad Hussein Dajani
Nazih Shalbak

Ministry of Municipal and Rural Affairs and the Environment (MMRAE)

Engineering Department

Lutfy S. Theodossy
Ayoub Abdulsalam
Ali Abu Rabiha

Environmental Department

S. N. Saadallah
Samch Gharaibeh

Ministry of Trade and Industry (MTI)

Ibrahim Kakish
Remon Halfeh

USAID

Harris F. Seidel (WASH Consultant)
F. W. Montanari (Washington)
Thomas A. Pearson
J.G. Cassanos
Albert Karian
Larry Brown
Edgar C. Harrell
Erick C. Harrell

Foreign Consultants:

VBB-Sweco

Kenneth Marelius
Bengt Froeman
Anders Gronvall

James M. Montgomery

Edward Shamieh

Malcolm Pirnie

Walter T. McPhee
Martin Daly

Local Consultants:

Consulting Engineering Center (CEC)

Aziz Abdo Sajdi

Mimar Consulting Engineers & Architects

Omar Nashashibi

Jouzy & Partners Consultants

Najeeb F. Tleel

National Planning Council (NPC)

Boulos Kefaya
Hussein Shafa'amri
Ferdose Shalibaz
Reem Bsiso
Sverker Skans

(Total of 44 participants the first day)

List of Conference Participants (March 29, 1981)

Water Supply Corporation (W.S.C.)

Said Beno
Aref Baha - Eddin
Human Ghuneim
Erik Berg

Amman Water Sewerage Authority (AWSA)

Ahmed Hadidi

Jordan Valley Authority (JVA)

Basim Mar'i
Maher Shihabi

Royal Scientific Society (RSS)

Hani Shaka'a

University of Jordan (UOJ)

Fuad Hashwa
Elias Salameh
Gerd Foerch

Ministry of Agriculture (MOA)

Naji Haddadin

Ministry of Health (MOH)

Mohamad Hussein Dajani
Nazih Shalbak

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Lutfy S. Theodossy
Ayoub Abdulsalam
Sameh Gharaibeh
Ali Abu Rabiha

Ministry of Trade and Industry (MTI)

Ibrahim Kakish
Remon Halfeh

USAID

Harris F. Seidel (WASH Consultant)
F. W. Montanari (Washington)
Faud Salabi
Aied Sweis
Abdallah Ahmad
Thomas A. Pearson
James G. Cassanos
Albert Karian
Larry Brown
Edgar C. Harrell

Foreign Consultants:

VBB-Sweco

Kenneth Marelius
Bengt Froman
Anders Gronvall

Malcolm Pirnie

Walter T. McPhee
Martin Daly

Local Consultants:

Mimar Consulting Engineers & Architects

Omar Nashashibi

Jouzy & Partners Consultants

Najeeb F. Tleel

Sigma Consultants

Suleiman Tashmen

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Boulos Kefaya
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(Total of 41 participants the second day)